Mansfield 2 a. 1

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Royal Observatory
Greenwich.

1877. June 6

Dear Sir

I have delayed somewhat in replying to your note – because just at present I am unable to say when I can be here to receive you – I am in fact daily ~~[illegible]~~ expecting a summons to attend in London on business in regard to which I shall receive very short notice – I had hoped to have been summoned before now. As soon as ~~[illegible]~~ this business is over – I will let you know and shall then hope to have the pleasure of seeing you in regard to your journals – and also of showing you the

results we have deduced from the Sun Dial observations - In regard to these observations the Registrar General has given in his annual Report for 1876 a brief summary for months - The record also appears now regularly in his Weekly Report.

I am going shortly to read a paper myself at the Meteorological Society on the Sun observations. about which I will give you further notice -

I am Dear Sir
yours very truly
William Ellis

J. J. Campbell Esq

The Meteorologist

88, London Street
Greenwich S.E.
1877. July 19

My dear Sir

I have received your note and propose to do myself the pleasure of paying you a visit on Sunday afternoon next. I was amused with your account of the Emperor's report about the Greenwich dial - which I had explained to him.

I am dear Sir
Yours very truly
William Ellis

J. A. Campbell Esq.

results we have deduced from the Sun Dial observations - In regard to these observations the Registrar General has given in his annual Report for 1876 a brief summary for months - The record also appears now regularly in his Weekly Report.

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William Ellis

J. A. Campbell Esq

[It is requested that all correspondence on the subject of this letter may be addressed to the Astronomer Royal.]

Royal Observatory, Greenwich,
London, S.E.

1877 July 18

Dear Sir

The two diagrams which you were so good as to leave for inspection on the occasion of your late visit, are packed up to come to you by carrier

We had the largest register of sunshine in June that we have recorded in one month since starting the instrument. a daily average of $8^h\ 54^m$.. the aggregate being 267 hours in the 30 days.

I am Dear Sir
yours very truly
William Ellis

J. F. Campbell Esq.

Read at the Annual Visitation of the Royal Soc... 1883, June 2.

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further notice.

I am B
yours
Wi

J. A. Campbell Esq

Not a sign of Thermography in this report June 2. 1883 They have not settled the question as to hot & cold Spots There no Thermography published Sept 22. 1883. — A copy sent to Ellis. Acknowledged on a Post Card. J.R.

REPORT

OF

THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH,

Read at the Annual Visitation of the Royal Observatory, 1883, *June* 2.

REPORT OF THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH,

Read at the Annual Visitation of the Royal Observatory, 1883, *June* 2.

The period to which the present Report refers comprises the twelve months ending 1883 May 20.

I. Buildings and Grounds, Moveable Property, and Library:—

The presentation of the Lassell two-feet reflecting telescope by the Misses Lassell, of which further mention will be made, has necessitated some alterations in the buildings and grounds. It has been mounted in the South Ground, and a circular building 30 feet in diameter has been erected in preparation for the dome. The dip and deflexion instruments have in consequence been moved from Magnetic Office No. 7 to the New Library.

The exterior of the Observatory Buildings and the interior of the Octagon Room have been painted under the supervision of the Director of Works of the Admiralty, to whom the charge of maintenance and repairs of the buildings has been transferred.

Under a new arrangement, several articles of office furniture have been supplied by the Director of Stores' Department.

The instruments purchased for the Transit of Venus 1874, after being used for the observation of the Transit of Venus 1882, have for the most part been returned to the Observatory. We have now in our hands one transit, two altazimuths, five equatoreals, one photoheliograph (mounted for daily use), and the mounting of another to which the Corbett telescope has been adapted. Three transits, one altazimuth, and one photoheliograph are at the Cape; two photoheliograph mountings (to which 6-inch object glasses have been applied) and a photoheliograph tube have been lent to the Eclipse Expedition 1883; a transit and an altazimuth have not yet been returned after observation of the Transit of Venus in Brisbane. The "Naylor" equatoreal, an altazimuth, and a clock (Dent 2015) were lost in the wreck of the "City of Brussels" on the voyage back from Bermuda.

R 7394. 900.—5/83. Wt. . E. & S.

Of the remaining clocks, four have been returned, one (Dent 1914) was presented to the Khedive after the Transit of 1874, and six are still in the charge of the Transit of Venus (1882) Committee. A photoheliograph tube is at South Kensington and another is in India.

Two 4-inch telescopes were lent to Captain Wharton, R.N., for observation of the Transit of Venus in the Straits of Magellan, and have not yet been returned. The rest of our portable instruments and clocks are in our hands.

The re-arrangement of books consequent on the building of the new Library has been completed. The sections Magnetism, Meteorology, Electricity, Statistics, Voyages, and General Literature, together with some serial works to which reference is seldom made, and all duplicates, have been transferred to the new building, books connected with Astronomy, scientific transactions, and ephemerides being kept in the two rooms forming the old library. Space has also been gained in the Record room by the transfer of some of the less important series of manuscripts to the new Library. A number of complete sets of the Greenwich publications have also been transferred to this building from the Depôt to diminish the risk of total destruction of our stock by fire. Some of our duplicates have at Dr. Doberck's desire been presented to the new Hong Kong Observatory. The books and manuscripts have, as usual, been compared with the catalogue. All are accounted for, with the exception of one small pamphlet, which has probably been mislaid.

II. Astronomical Observations :—

Transit-Circle.—The new mountings of the collimators, to which allusion was made in the last Report, as being constructed by Mr. Simms, were brought into use last summer, and have been found to work well in practice. They allow of the collimators being turned on one side about centres below when not in use, and thus it has been found practicable to observe stars by reflexion as far as Z.D. $71\frac{1}{2}^{\circ}$, an alteration having also been made in the mounting of the mercury trough by which it has been raised about a foot. The stability of the collimators during each determination of collimation is regularly tested by observations for coincidence of the corresponding wires of the two collimators taken immediately after as well as before the observation of the collimators with the transit-circle, and is found to be perfectly satisfactory. The changes in azimuth from day to day are usually no larger than with the old mounting, though this condition is not essential to the efficiency of the collimators for determination of collimation error.

The regular subjects of observation are the Sun, Moon, planets, and fundamental stars, with other stars from a selected list. The working catalogue of 2,500 stars down to the fifth magnitude having been cleared off, a new working list of 2,600 stars, comprising all stars down to the sixth magnitude inclusive which had not been observed since 1860, has been prepared, and was brought into use at the

beginning of March. About 1,200 stars were observed in 1882, but amongst these there are nearly 500 single observations, necessitating careful comparison with catalogue place for the detection of any mistakes of observation or reduction. The labour thus entailed is considerable, and efforts will be made to obtain in this and each future year at least two observations of every star observed.

The following statement shows the number of observations with the Transit-Circle made in the year ending 1883, May 20 :—

Transits, the separate limbs being counted as separate observations	4488
Determinations of collimation error	354
Determinations of level error	323
Circle observations	4485
Determinations of nadir point (included in the number of circle-observations)	298
Reflexion-observations of stars (similarly included)	484

Comet *a* 1882 has been observed seven times on the meridian since the date of last Report, and Comet *b* 1882 has been observed three times.

As regards the computations,—

Clock times of transit over the true meridian after all corrections for instrumental errors are prepared to	1883 May 13
Clock errors and rates are determined to	May 5
Mean R.A.'s on 1883 January 1 are formed to	April 25

The investigation of personal equations has been completed for the year 1882, the results being very accordant with those found in the preceding year.

The circle observations are completely reduced so as to form mean N.P.D. for 1883 January 1 to April 21, apparent Z.D.'s being formed to April 28.

From the beginning of this year a correction of $-0''{\cdot}39$ has been applied to the results of the Nadir observation to make them agree in the mean with the results of reflexion observations of stars. This correction has been deduced from a comparison of the Nadir results throughout 1882 with corresponding reflexion-results for stars north and south of the zenith. The discordance appears to be increasing, and its source has not yet been traced. It does not appear to originate on this occasion with the microscope-micrometers or telescope-micrometer, and it is not connected with the extension of the range of observation of stars by reflexion. The discordance, which was insignificant in 1878, amounting only to $-0''{\cdot}03$, has gradually increased since, being $-0''{\cdot}10$ in 1879; $-0''{\cdot}29$ in 1880; $-0''{\cdot}30$ in 1881; $-0''{\cdot}39$ in 1882; and for the first four months of this year $-0''{\cdot}58$.

Determinations of flexure have been made on 1882 December 30 and 1883 May 10 and 18, the resulting values being $-0''{\cdot}07$ and $-0''{\cdot}78$ and $-0''{\cdot}33$. The observations on May 18 were not altogether satisfactory, as the Sun was shining during

the second set of measures. The values resulting from the first and second sets respectively are $-0''\cdot72$ and $+0''\cdot05$. There is apparently nothing in the observations on May 10 to account for the exceptionally large value found on that day. No correction for flexure, as apart from the correction for R—D, has been applied to the observations.

The correction for R—D, the error of assumed colatitude, and the position of the ecliptic have been investigated for 1882. For the planetary results, errors of R.A. and N.P.D. have been formed, but the heliocentric errors have not yet been computed.

The reflexion observations of stars available for investigation of the R—D discordance extend from Z.D. $71\frac{1}{2}°$ north to Z.D. $70\frac{1}{2}°$ south, and the discussion of these shows discordances steadily increasing from the zenith towards the horizon, and amounting to $-1''\cdot58$ for the group at Z.D. $68\frac{1}{4}°$ north and to $+1''\cdot66$ at Z.D. 70° south, a correction of $+0''\cdot16$ Sin Z.D. having been first applied to the reflexion observations for inclination of the vertical at the mercury trough. It is quite evident that the discordances do not follow any such law, as $a + b$ Sin z . $\mathrm{Cos}^2 z$, which was used from 1862 to 1880. Assuming the law $a + b$ Sin z, which was adopted in the years preceding 1862 and in 1881, the R—D correction for 1882 would be $+0''\cdot07$ $+0''\cdot42$ Sin z, and for the sake of continuity in the system of reductions this correction has been provisionally adopted for use in 1882. But the discordances between this formula and the observed quantities increase regularly from the zenith towards the horizon, amounting to half of the observed quantities at Z.D. 50° to 60°. The formula $+0''\cdot08 + 0''\cdot29$ Tan z represents the observations better, though even this does not give sufficiently large results at large zenith distances. In this discussion corresponding reflexion and direct observations made on the same day have alone been used.

The value found for the co-latitude from the observations of 1882 is $38°.31'.21''\cdot93$, very slightly larger than the assumed value; the correction to the tabular obliquity of the ecliptic is $+0''\cdot44$; and the discordance between the results from the summer and winter solstices is $+0''\cdot37$.

The mean error of the Moon's tabular R.A. from observations with the transit-circle in 1882 is $+0^s\cdot82$.

Altazimuth.—In order to adapt the instrument to the occasional observation of bright comets, a new system of wires, having central cross wires thicker than the others, was inserted at the beginning of this year. Since the lunation ending 1882 July 9, the observations of the Moon with this instrument have been restricted to the first and last quarters of each lunation, it being considered that the intermediate semi-lunation is sufficiently provided for by the meridian observations. It is proposed, however, to make occasionally determinations of the Moon's diameter in azimuth and zenith distance at the time of Full Moon.

The following observations have been made with the Altazimuth from 1882 May 20 to 1883 May 20:—

Azimuths of the Moon and stars	317
Azimuths of the azimuth-mark	228
Azimuths of the collimating-mark	216
Zenith-distances of the Moon	176
Zenith-distances of the collimating-mark . . .	214

Azimuths and zenith distances of Comet *b* 1882 were observed on a single day.

The altazimuth observations are completely reduced to May 6, so as to exhibit errors of Moon's tabular R.A., N.P.D., longitude, and ecliptic N.P.D. The restriction of the observations, and the limitation of the computations to $0^{s}\cdot01$ and $0''\cdot1$ have made these reductions comparatively light.

The following is a comparison of the number of days on which complete observations of the Moon were obtained with the transit-circle and altazimuth respectively:—

Moon's Time of Meridian Passage.	Transit-Circle.	Altazimuth.
0^h to 1^h mean solar time . . .	0	1
1^h to 2^h „ . . .	0	3
2^h to 3^h „ . . .	0	5
3^h to 4^h „ . . .	1	9
4^h to 5^h „ . . .	3	7
5^h to 6^h „ . . .	6	9
6^h to 9^h „ . . .	29	11
9^h to 12^h „ . . .	22	6
12^h to 15^h „ . . .	21	3
15^h to 18^h „ . . .	10	2
18^h to 19^h „ . . .	3	11
19^h to 20^h „ . . .	3	6
20^h to 21^h „ . . .	2	6
21^h to 22^h „ . . .	0	7
22^h to 23^h „ . . .	0	2
23^h to 24^h „ . . .	0	0

The whole number of places of the Moon observed with the transit-circle, is 100, or 8·1 per lunation.

The Moon's diameter has been measured—

With the transit-circle, twice in R.A., 17 times in N.P.D.
With the altazimuth, 4 times in azimuth, 10 times in Z.D.

Clocks and Chronograph.—The system of registering the alternate seconds from the Sidereal Standard directly on the chronograph has been continued, and is found perfectly satisfactory. The Sidereal Standard has been recently cleaned.

Reflex Zenith Tube.—A prismatic focussing rod with scale reading to 1-200th of an inch and ivory point for contact with the surface of the mercury has been applied to the instrument in place of the former light brass rod and wooden float. The focussing rod and the micrometer frame are both of gun metal. A complete system of 30 wires has been inserted in the micrometer frame, and it is proposed to determine the scale value corresponding to different temperatures and to different readings of the focal length by means of transits of γ Draconis over the 30 wires in order to obtain the correction for effect of temperature on the results with the reflex zenith tube. This arrangement was brought into operation in April, and sets of transits have been obtained on four nights. The observations of γ Draconis are completely reduced to the end of 1882, and the copy for press is prepared.

Equatoreals.—A very valuable addition has been made to the instruments of the Royal Observatory by the gift of the Lassell two-feet reflecting equatoreal, which has been generously presented by the Misses Lassell. The exceptional qualities of this fine telescope (with which Hyperion was discovered in 1848) are well known, and there could be no hesitation in accepting on the part of the Admiralty the offer of such a valuable gift. The instrument was removed from Maidenhead early in March, and has been erected in the South ground, where it commands a nearly unobstructed view of the sky to within about 5° of the horizon. A circular building 30 feet in diameter has been erected for the Lassell telescope, and the construction of a suitable dome is authorized. There are two large mirrors available for use, and I contemplate taking advantage of the firm mounting and perfect clock movement of the South-east equatoreal to mount the spare mirror on this instrument, attaching it to the tube of the refractor, so as to have on the same mounting a refractor and reflector with their axes parallel. The former would be available for eye observation, whilst the latter could be used on the same object for physical work, spectroscopic or photographic. The Lassell telescope itself would be well suited for observation of faint satellites and comets which are beyond our present instrumental means.

The South-east and Sheepshanks equatoreals are in good working order. The loss of the Naylor equatoreal by shipwreck has already been mentioned. One of the Simms' 6-inch equatoreals, recently repaired after use in the late Transit of Venus, is being mounted in the South ground for occasional use.

With one or more of these equatoreals, or with the altazimuth, 11 occultations of stars by the Moon (7 disappearances and 4 reappearances) and 37 phenomena of

Jupiter's satellites have been observed in the twelve months ending 1883 May 20, and the observations of occultations have been reduced to the end of 1882. The great Comet *b* 1882 was observed on 10 nights, and Comet *a* 1883 (Brooks-Swift) was observed on 4 nights with the Sheepshanks Equatoreal. Comet *c* 1882 (Barnard) was observed on one night with the South-east equatoreal. Micrometer observations of six of Saturn's satellites (including 2 measures of Enceladus) were made with the South-east equatoreal on 9 nights, and with the Sheepshanks equatoreal on 6 nights, but in these last it appears that Titan was the only satellite observed. Four measures of Titania, the third satellite of Uranus, were also obtained on one night.

A number of observations of the double stars Castor, γ Leonis, γ Virginis, and ζ Ursæ Majoris have been made on 6 nights with the Airy double-image micrometer on the Sheepshanks Equatoreal, mainly with a view of practising the observers in micrometer observations.

Preparations were made for observing the Transit of Venus on December 6, but clouds completely hid the Sun from view during the time of the transit.

The observations of the solar eclipse of 1882 May 17 with the South-East Equatoreal are completely reduced, and the final equations have been solved.

III. Spectroscopic and Photographic Observations:—

The spectroscopic observations during the past twelve months have been somewhat restricted through the pressure of the photographic reductions at a time of maximum of sun-spot frequency. The solar prominences have been observed with the half-prism spectroscope on 8 days, and four sun-spots have been examined on 8 days with reference to the broadening of lines in their spectra. The spectrum of the great spot of 1882 November 12–25 showed some remarkable reversals of the lines of hydrogen and sodium, and an extraordinary displacement of the F line.

As regards the determination of motions of stars in the line of sight, 142 measures have been made of the displacement of the F line in the spectra of 23 stars, and 26 measures of the b_1 line in 9 stars. The observations of Sirius during the past winter tend on the whole to confirm the impression that the rate of recession of this star has diminished progressively since 1877, and that the motion is now on the point of being converted into one of approach.

The spectrum of Comet *a* 1882 was examined on three nights, that of the great Comet *b* 1882 on three nights, and that of Comet *a* 1883 on one night. The spectrum of the first-named object showed the yellow sodium lines with great brilliancy just before perihelion passage. The spectrum of the aurora of 1882 November 17 was also examined.

The spectroscopic observations of all kinds have been completely reduced to 1883 May 20.

In the year ending 1883 May 20 photographs of the Sun have been taken on 200 days, and of these 339 have been selected for preservation. There were 7 days on which the Sun's disk was observed to be free from spots. The number and size of spots and faculæ continued to increase in a marked way till last November, when a group of spots of very unusual size appeared. Since that date, however, the Sun has become more quiescent.

Since the beginning of December gelatine dry-plates have been used instead of the old wet-plate process. They are more convenient in use, and appear to give as good average results. The photographs on a scale of eight inches to the Sun's diameter recently obtained in India, under the auspices of the Solar Physics Committee, are so successful that the Committee have recommended the general adoption of this scale, and I propose, as soon as we have a spare photoheliograph returned from the Eclipse Expedition, to have it altered in the same manner as the Indian photoheliograph, so as to obtain eight-inch photographs of the Sun instead of four-inch.

It was suggested in the last Report that the measurement of such of the Indian and other photographs as were required to fill up gaps in the Greenwich series might with advantage be undertaken here. This proposal has now been carried out, and 111 photographs for the period from 1881 December 22 to 1882 October 19 have been received from the Solar Physics Committee, so that a record of the condition of the Sun on 279 out of the 302 days in that interval is now presented. From 1882 October 20 eight-inch photographs were taken in India, and for the measurement of these a special micrometer has been ordered of Messrs. Troughton and Simms by the Solar Physics Committee.

As regards the photographic reductions:

The photographs have been measured in duplicate, and the measures entered, to	1883 April 3
Radii of the Sun, Corrections for zero of position-circle, and Heliographic elements, have been computed to . .	April 3
Distances from the Sun's centre and Position-angles of spots and faculæ, corrected for distortion and refraction, have been formed to	March 9
Heliographic longitudes and latitudes of spots have been computed to	March 9
The areas of spots and faculæ have been completely reduced, so as to exhibit areas in millionths of the Sun's visible surface, to	March 9

All the photographs received from the Solar Physics Committee have been measured in duplicate, and the measures have been completely reduced so as to exhibit heliographic longitudes and latitudes of spots, and areas of spots and faculæ, from 1881 December 22 to 1882 October 19, the end of the series of four-inch photographs.

IV. Magnetical Observations:—

The course of observation continues the same as in former years, changes in the magnetic declination, horizontal force, and vertical force being continuously recorded by photography with the three magnetometers, whilst absolute values of magnetic declination, dip, and horizontal force are found by eye observation. Earth-currents in two directions nearly at right angles to each other are also photographically registered.

A great improvement has been made in the photographic registration by the substitution in June last of Morgan and Kidd's argentic-gelatino-bromide paper with ferrous oxalate development for the old photographic process. The greatly increased sensitiveness of the new photographic paper allows of a great reduction in the effective surface of the concave mirrors carried by the magnets and in the size of the gas flames. Much greater sharpness in the photographic trace is thus secured, and there is no trouble from discoloration. The saving in gas and in Computers' time in preparing and developing the sheets probably makes up for the increased cost of the paper, which is rather expensive.

The large temperature correction of the vertical force magnet has been reduced to less than one fourth of its former amount by some alterations which were carried out by Mr. Simms last autumn. The most important of these was the substitution of a smaller and much lighter mirror, one inch in diameter, for the mirror of four inches diameter, formerly used with the wet paper photographic process, the balance weight on the horizontal stalk being shifted to the opposite side. The distance of the line of knife-edges above the centre of gravity has also been diminished, the balance weight on the vertical stalk being made smaller and brought much nearer the knife-edge. The effect of these alterations has been to reduce the correction for change of 1° Fahrenheit from 0·00088 of the Vertical Force to about 0·00020. The coefficient has, however, still the opposite sign to that which would result from mere loss of magnetic power with increase of temperature. It is intended to make an attempt to still further diminish the temperature correction by shifting the magnet in its carrier so as to reduce the horizontal stalk and balance weight.

The driving clock of the Vertical Force and Barometer cylinder has been altered so that the length of time scale is now the same as that for the other magnetic and meteorological registers, excepting only the thermometer time scale, which is much shorter.

It was remarked in the last Report that the earth-current registers frequently showed abnormal disturbance during rain. By the kindness of Mr. Leonard (the successor to the late Mr. C. V. Walker, as telegraph engineer of the South-Eastern Railway,) the wires were repaired in February, and the rain disturbance seems now to have disappeared.

The erection of the Lassell telescope in the South ground has rendered necessary the removal of the Dip and Deflexion instruments from Magnetic Office No. 7 to a new position. The most convenient place appeared to be the new Library, in the building of which all magnetic materials were carefully excluded, and the two instruments have accordingly been mounted there on substantial wooden stands with slate tops, resting on firm foundations. Before deciding finally on this position, and previous to the introduction of the Lassell telescope, the time of vibration of the magnet used in the deflexion experiment was carefully determined both in Magnetic Office No. 7 (the old position) and in the newly selected position in the Library, and the results were found to be precisely the same in the two places. A careful examination of the magnetic registers on March 3 and 9, when the parts of the Lassell telescope were brought into the Observatory, does not show any disturbance of the declination or horizontal force magnets as resulting from the location of this mass of iron on the South ground.

As regards the magnetic reductions, the eye-observations of the upper declination magnet and of the horizontal and vertical force magnets, giving zeros for the ordinates of the photographic curves, are reduced to the end of the year 1882.

The time-scales for declination and horizontal and vertical force are complete to the end of 1882, and the base line values are formed. These are entered on the photographic sheets, and new base lines are laid down completely for declination and horizontal force, and partly for vertical force.

The hourly ordinates of the photographic curves are read out to the end of 1882 for declination and horizontal force. The time-scales for the earth-currents are laid down for five months of 1882. The observations of dip are completely reduced; those for absolute horizontal force are reduced to the end of 1882.

The following are the principal results for magnetic elements for 1882 :—

Approximate mean westerly declination . .	18°. 22′.
Mean horizontal force	3·913 (in English units). 1·804 (in Metric units).

Mean dip . . . . . { 67° 33′ 33″ (by 9-inch needles).
67. 34. 34 (by 6-inch needles).
67. 34. 14 (by 3-inch needles).

There has been considerable magnetic activity during the year, the month of November, which was characterized by the appearance of a very large sun-spot, being particularly disturbed with remarkable magnetic storms on November 17, 19, and 20, and many interesting cases of lesser disturbance. The magnetical changes in November are so interesting in relation to the accompanying outburst of sun-spots that it seems desirable to have the registers for a great part of the month as well as for other days of magnetic disturbance in the year lithographed in the "Greenwich Magnetical Results for 1882" on a reduced scale. The character of a disturbance would, I think, be much better shown by a reproduction of the curves traced on the photographic sheets than by tables of numerical values of ordinates. I am making enquiries as to the practicability of using some anastatic process, which would not be very expensive.

The magnetic disturbances on October 2 and November 17 were accompanied by brilliant auroras.

Particulars of magnetic disturbances are regularly communicated to the "Colliery Guardian" newspaper for the information of mining surveyors.

V. Meteorological Observations:—

The meteorological instruments and the Thomson electrometer are all in good order. A flexible brass chain has been substituted for the stiff copper wire connecting the pressure plate of Osler's anemometer with the recording pencil. The smaller pressures of $\frac{1}{2}$ lb. and less are now very satisfactorily registered, and as regards the larger pressures, the records hitherto obtained throw some doubt on the results with the copper wire. On the occasion of the gale of 1882 October 24, a velocity of 64 miles an hour was registered with Robinson's anemometer for two successive hours, being greater than any velocity previously recorded here, but the greatest pressure registered with the chain was only 29 lbs. on the square foot, whilst on 1882 April 29 a pressure of 49$\frac{1}{2}$ lbs. was recorded with the copper wire at a time when the velocity was only 50 miles an hour. The stiffness of the copper wire would appear to have exaggerated some of the largest pressures, and to have prevented the record of any of the very small pressures. The pressure scale on the paper was redetermined after the application of the brass chain, and was found to be almost precisely the same as before for large pressures. There were, however, some little differences in the portion of the scale applying to small pressures.

The observations of temperature of the Thames have recently been resumed under the charge of the Corporation of London, who have instructed Mr. G. J. Symons to arrange details. The observations are now made at the end of one of the jetties of the Foreign Cattle Market at Deptford, where a record is to be kept (by means of two Six's thermometers) of the daily maximum and minimum temperatures of the Thames at a depth of two feet below the surface, and also near the bottom of the river. Mr. Symons has arranged that these observations shall be regularly communicated to the Royal Observatory to be included in the meteorological table published weekly in the Registrar General's Reports.

Comparisons have been made during the past year between the readings of the two pairs of maximum and minimum radiation thermometers when exposed in the Magnetic Ground and South Ground respectively, and also when exposed side by side in the Magnetic Ground (for determination of the differences in their index errors). The general result of these observations is that the solar radiation temperature is somewhat higher in the Magnetic Ground than in the South Ground, and that there is little difference between the terrestrial radiation temperatures in the two situations, though, on the whole, the lowest temperatures are registered in the Magnetic Ground.

The following is the state of the meteorological reductions:—The observations of barometer, thermometers, anemometers, rain-gauges, and sunshine instrument (corrected, where necessary, for instrumental error) are reduced up to the present time. On the photographic sheets time-scales are laid down for the barometer and dry and wet bulb thermometers to the end of 1882, and for the electrometer to June 30. The hourly ordinates for the barometer and dry bulb thermometer are read out to the end of 1882, for the wet bulb thermometer to June 30, and for the electrometer to 1882 January 31. The hourly and monthly means in 1882 have been commenced for the barometer.

The mean temperature of the year 1882 was 49°·6, being 0°·1 lower than the average. The highest air temperature was 81°·0 on August 6, and the lowest 22°·2 on December 11. The mean monthly temperature was above the average from January to May, then below until September. In October, November, and December it differed little from the average.

The mean daily motion of the air in 1882 was 306 miles, being 27 miles greater than the average. For the month of November the mean daily motion was 449 miles, being 159 miles above the average. The greatest daily motion was 758 miles on November 4, and the least 30 miles on December 11. As already mentioned the

greatest hourly velocity was 64 miles an hour, and the greatest pressure (with the chain) 29 lbs. on October 24.

During the year 1882 Osler's anemometer showed an excess of 11 revolutions of the vane in the positive direction N, E, S, W, N, if all the turnings are counted (as has been the practice in former years); or of 23 revolutions in the positive direction if the turnings which are evidently accidental are excluded.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1882 was 1245, which is more than 40 hours above the average of the five preceding years.

The rainfall in 1882 was 25·2 inches, being very slightly above the average.

Certain particulars in regard to the effect of the change in the barometer or thermometer in the course of each month on the monthly values of diurnal inequality as given in the 20 years' Meteorological Reductions have been supplied to Gen. Strachey. Tracings of the Osler anemometer records from 1882 September 1 to November 24 have been made for Mr. G. J. Symons.

VI. Printing and Distribution of the Greenwich publications:—

The volume of Greenwich Observations 1880 was distributed last July, and the volume for 1881 was passed for press at the beginning of April. The copies are still in the binder's hands. [A few copies have been received while this Report was passing through the press.]

As regards the volume for 1882, the transits are printed to February 1, azimuths with the altazimuth to March 30, and zenith distances to June 26. The whole of the MS. of these sections and of the meridian zenith distances for 1882 is in the printer's hands. Proofs have been received of the whole of the spectroscopic observations for 1882. The photographic results for 1882 cannot be completed until the new micrometer for the measurement of the eight-inch Indian photographs from 1882 October 20 has been completed. Their publication will therefore suffer some unavoidable delay, though not to any serious extent.

The Magnetic and Meteorological Introduction has been entirely re-written for 1881. It has been re-arranged and condensed, portions which had become obsolete in course of years being omitted. The Astronomical Introduction has also been somewhat condensed, and the tables relating to the Transit-Circle have been collected

together and placed at the end, where they will be more conveniently arranged for reference. As these tables contain much useful information in a compact form, they have been included in the Astronomical Results, together with the Star Ledgers, which are useful as giving the individual results of each observation.

VII. Chronometers and Time Signals :—

The number of chronometers now being tested at the Observatory is 154. Of these 114 (77 box-chronometers, 16 pocket-chronometers, and 21 deck-watches) are the property of the Government, and are being rated after repair previous to their issue to the Navy. The remaining 40 are placed here for the annual competitive trial, and of these 8 are fitted with Airy's supplementary compensation. In addition to the above, 5 chronometers have been tested here for the new Hong Kong Observatory.

The first six chronometers in 1882, as tested by their trial numbers, are on the average better than the first six in any year since 1873, and the first chronometer performed better than any we have had previously on trial. The trial in cold was, however, not quite so severe in 1882 as in preceding years.

There has been no case of failure in the automatic drop of the Greenwich time-ball. On three days the ball was not raised on account of the violence of the wind.

The Deal time-ball has been dropped automatically at 1^h on every day throughout the year, with the exception of 5 days, on which there was failure in the telegraphic connexion, of one day when the ball was accidentally dropped 4^s too soon by telegraph signals, and of 14 days when the current was weak and the trigger was released by the attendant without appreciable loss of accuracy. On 12 days the ball was not raised on account of the violence of the wind.

Mr. Leonard has expressed a wish to make other arrangements for the dropping of the Deal ball, as he proposes to use for another purpose the wire from Greenwich to London Bridge, by which time signals are sent to the South-Eastern Railway and the Deal ball is dropped independently of the signals sent to London by the Post Office wire. It has been ascertained that the Deal ball could be dropped through the Post Office connexions and a return signal to Greenwich given, but no further step in the matter has yet been taken.

The Westminster Clock has maintained its high character, its errors having been under 1^s on 66 per cent. of the days of observation, between 1^s and 2^s on 25 per

cent., between 2^s and 3^s on 6 per cent., and between 3^s and 4^s on 3 per cent. The error has never exceeded 4^s.

VIII. Personal Establishment :—

The staff is thus constituted :—

Mr. Dunkin, Chief Assistant ;
Mr. Ellis, Mr. Criswick, and Mr. Downing, First Class Assistants ;
Mr. Maunder, Mr. Thackeray, Mr. Lewis, and Mr. Hollis, Second Class Assistants ; and
Mr. Nash, Magnetical and Meteorological Assistant.

The duties of the establishment are thus distributed, some changes having been made since the last Report, consequent on the limitation of the Altazimuth observations, and the increase in the photographic reductions :—

Mr. Dunkin superintends generally all the work of the Observatory. Mr. Criswick has charge of the transit-reductions and miscellaneous computations. Mr. Downing undertakes the circle-reductions. Mr. Thackeray has the care of the library and manuscripts, of the chronographic transits, and of stores and stationery. Mr. Lewis has the charge of the time department, including chronometers, and of the money accounts. Mr. Hollis is charged with the altazimuth-reductions, and with the measurement and reduction of the Indian photographs. Mr. Maunder superintends the spectroscopic and photographic reductions. In the Magnetic and Meteorological branch, Mr. Ellis has the general superintendence of the work, Mr. Nash being specially charged with the meteorological reductions and with the care of the instruments.

There are eight or nine computers usually attached to the Astronomical Department, and three or four to the Magnetic and Meteorological.

The regular astronomical observations are made by Messrs. Downing, Thackeray, Lewis, and Hollis, alternately with the transit-circle and altazimuth or equatoreal ; and the spectroscopic observations by Mr. Maunder and by Mr. Nash, who since the autumn of last year has undertaken a share in the observing duty. The solar photography and the meteorological observations are usually entrusted to computers, some of whom are also available at times of pressure for astronomical observations.

I would take this opportunity of expressing my thanks to the Assistants for the zealous spirit in which they have worked to maintain the credit of the Observatory.

A gate-porter, watchman, and labourer, and a foreman of works, with two carpenters and a labourer, complete the establishment.

It may be proper to mention here that Dr. Doberck, the Director of the new Hong Kong Observatory, lately spent some time at this Observatory in making himself acquainted with our methods of observation and reduction; and that Lieut. Moody, R.N., Assistant Instructor in Nautical Astronomy at the Royal Naval College, is now attending here for the same purpose.

IX. General Remarks:—

The changes suggested in the last Report have been carried out, and will, I trust, tend to increase the efficiency of the Observatory.

The restriction of the altazimuth observations of the Moon to the semi-lunation from last quarter to first quarter has enabled us to devote more attention to equatoreal observations, though the results hitherto obtained have been somewhat limited through the inadequacy of our instrumental means. The presentation of the Lassell telescope has now removed this difficulty, and when this fine instrument is in working order we may hope to be able to take up with success observations of comets, faint satellites, and other objects of interest.

In regard to the spectroscopic observations we have now two observers available, and it may be expected that in the coming year we shall reap the full benefit of the arrangement by which Mr. Nash takes a share in this work.

In solar photography we have undertaken the measurement and reduction of Indian photographs, supplementing those taken at Greenwich from the commencement of 1882. The Solar Physics Committee propose to undertake the arrears of this work for preceding years.

In some slight degree the past year has been one of transition and of preparation for future work. Some administrative changes have been made, and the observers have been gaining experience in some new directions; but the regular course of observation and reduction has not been disturbed, and it has been my special endeavour to maintain the standard meridian observations in full vigour,—a task in which I have received the hearty co-operation of all the staff.

In regard to the coming year, I may mention one special work of meteorological reductions which it seems desirable to take in hand. The hourly ordinates of barometer and thermometer registers have been read out and tables of mean values formed for the 20 years of the Meteorological Reductions, and also year by year since 1877; but there is a gap of three years for the barometer (1874–1876), and of eight years for the thermometers (1869–1876), for which the photographs have not been discussed. The continuity of the Greenwich series is thus broken, and the results are not available to their full extent. The discussion which I contemplate for the years in question would probably occupy one computer for a year and a half, involving an outlay of about 70*l*.

W. H. M. CHRISTIE.

Royal Observatory, Greenwich,
1883, *May* 21.